



2003 AFCEE Technology Transfer Workshop

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Promoting Readiness through Environmental Stewardship

A Workable Definition of Success

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A Hierarchy of Success.

- After remediation, ground water in entire plume treated to MCLs
- After remediation, hotspot actively contained, and plume outside containment treated to MCLs
- After remediation, plume confined to NAPL source area by natural processes
- Plume receding when it was expanding before remediation.
- Plume stabilized when it was expanding before remediation.



What are Plumes Like?

Data on the next slides are from:

Evaluating Chlorinated Hydrocarbon Plume Behavior Using
Historical Case Population Analyses

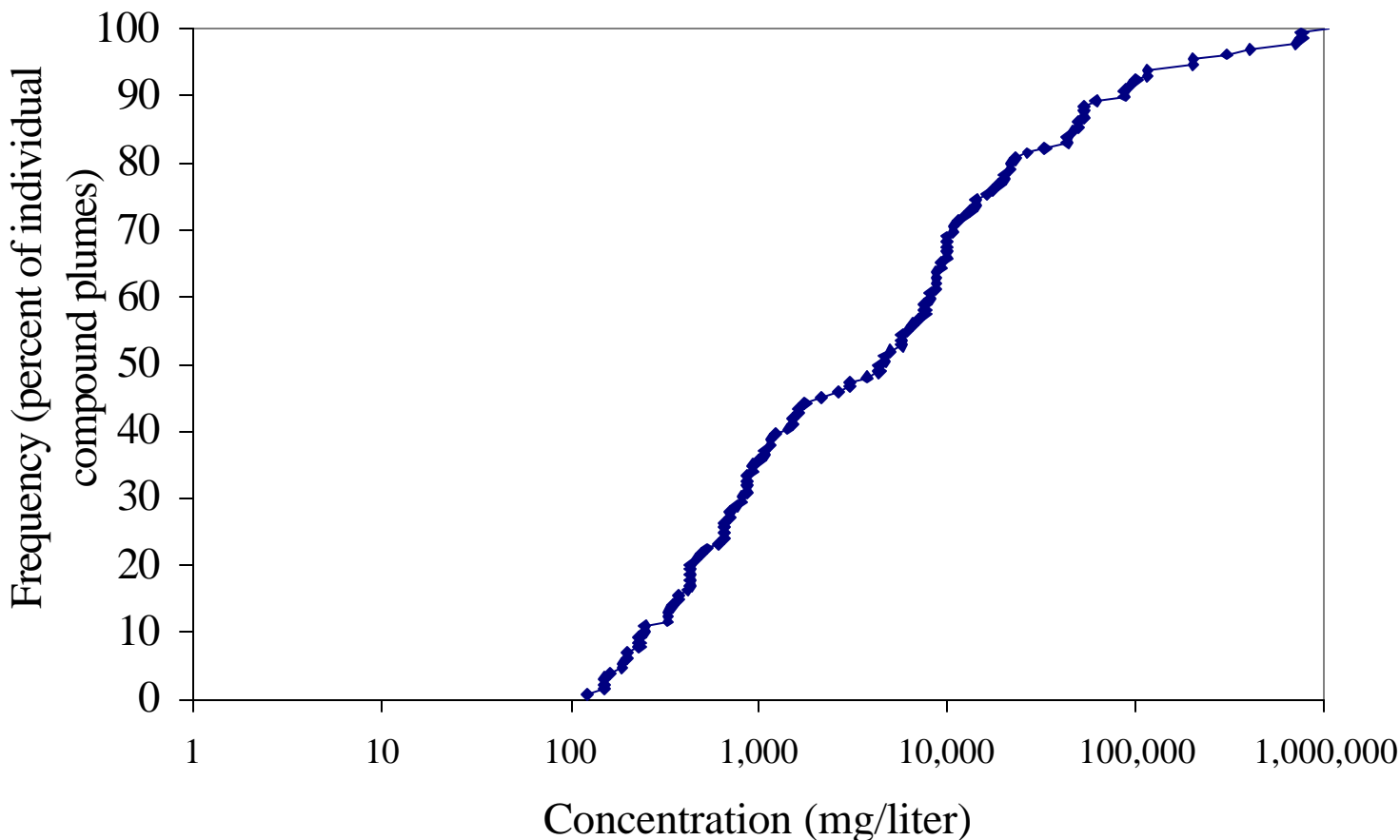
Walt W. McNab, Jr. David W. Rice, and Cary Tuckfield

Bioremediation Journal 4(4):311-335. (2000)



What are Plumes like?

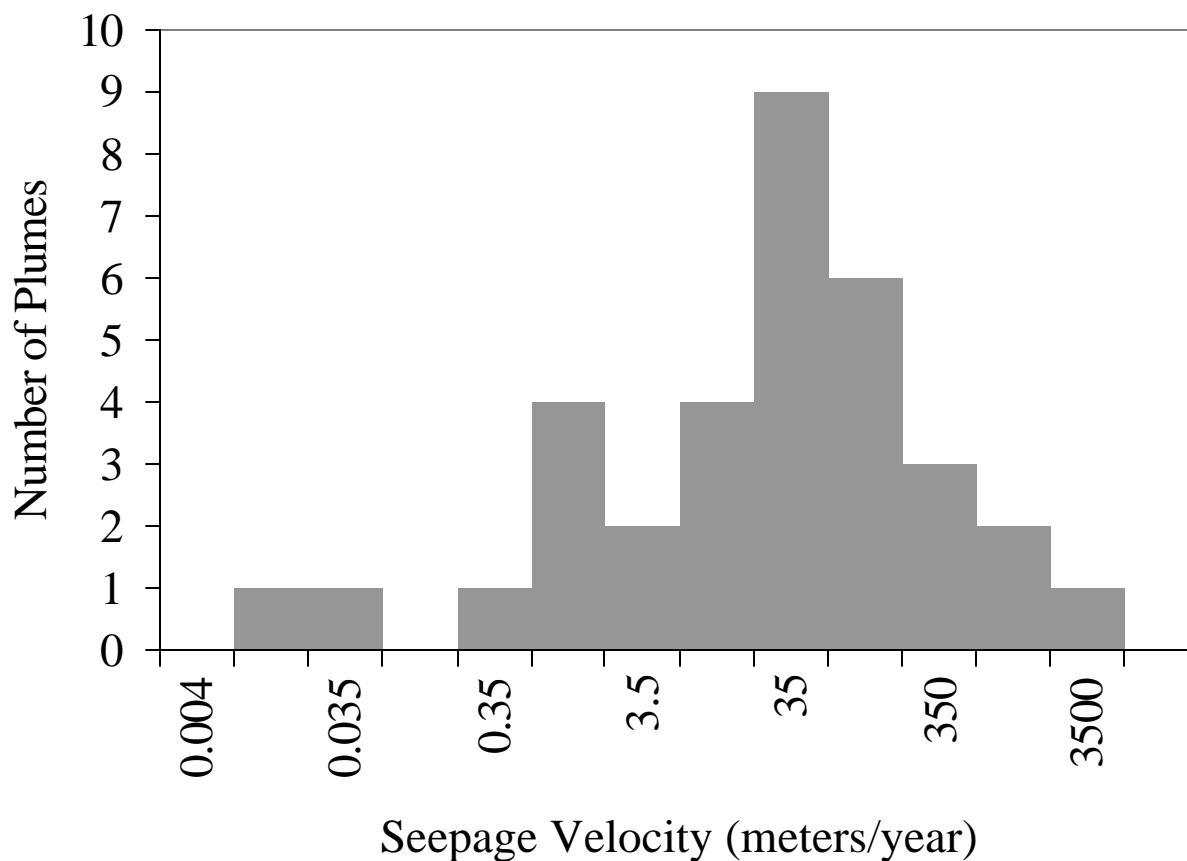
Maximum Concentrations of Chlorinated Organics





What are Plumes Like?

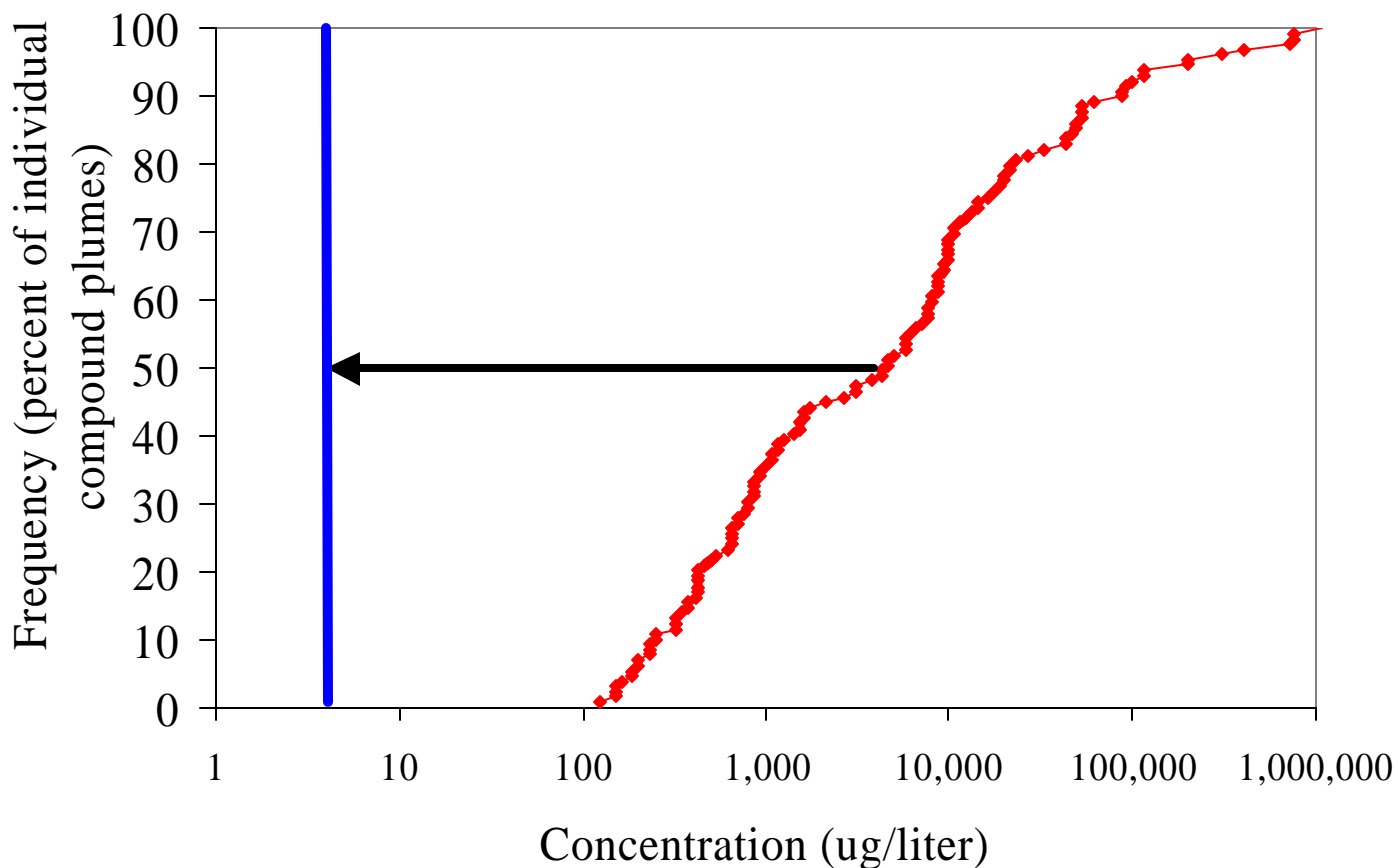
Seepage Velocity of Chlorinated Solvent Plumes in USA





How much Cleanup is Needed?

Maximum Concentrations of Chlorinated Organics





Performance of Remediation

Extent of Removal	Typical Evaluation
<50%	Back to the drawing board.
>70%	Looks promising, let's do more R&D.
>90%	About average, a success.
>99%	A substantial success.



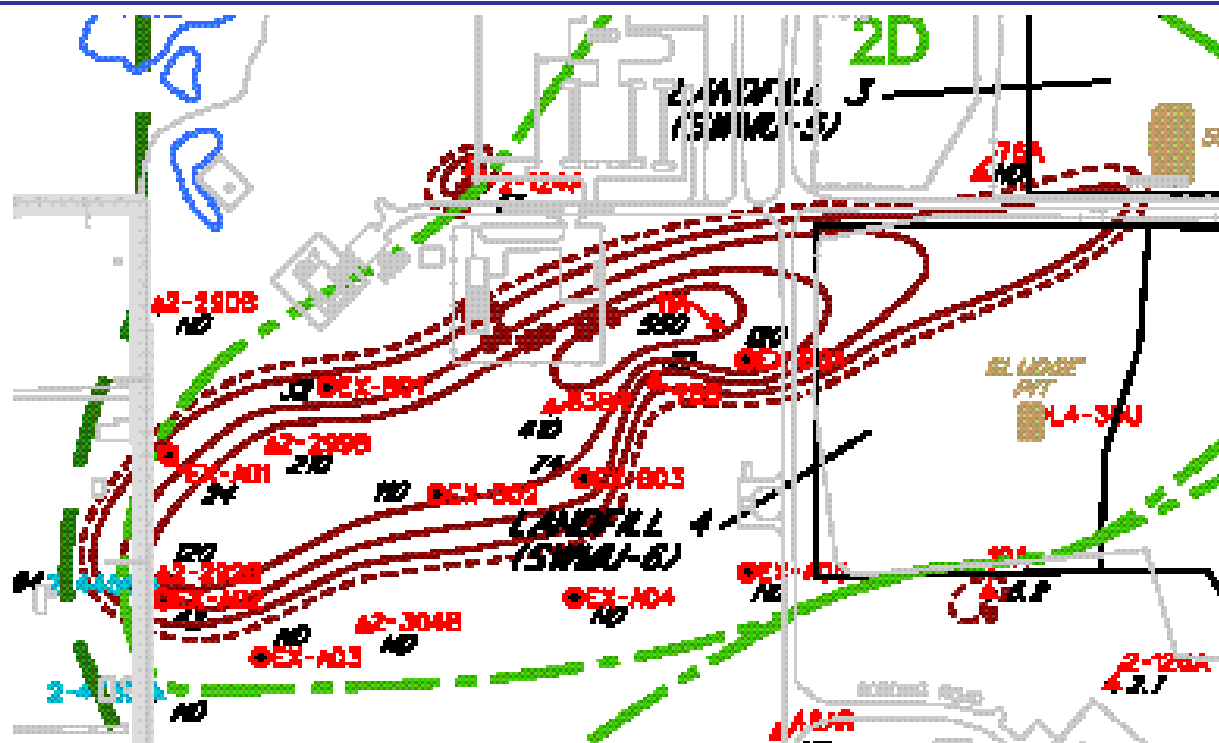
Why so Little Removal?

- The contaminants are not uniformly distributed in the aquifer.
- Flow of ground water is heterogeneous.
- It is difficult to mix remedial fluids with the contaminants.



What are Plumes like?

Not Like This!



**(Basewide) Upper Saturated Zone
Isopleth Map-Trichloroethene
2000, Tinker Air Force Base,
Oklahoma**



What are Plumes like?

More Like This





What are Plumes like?

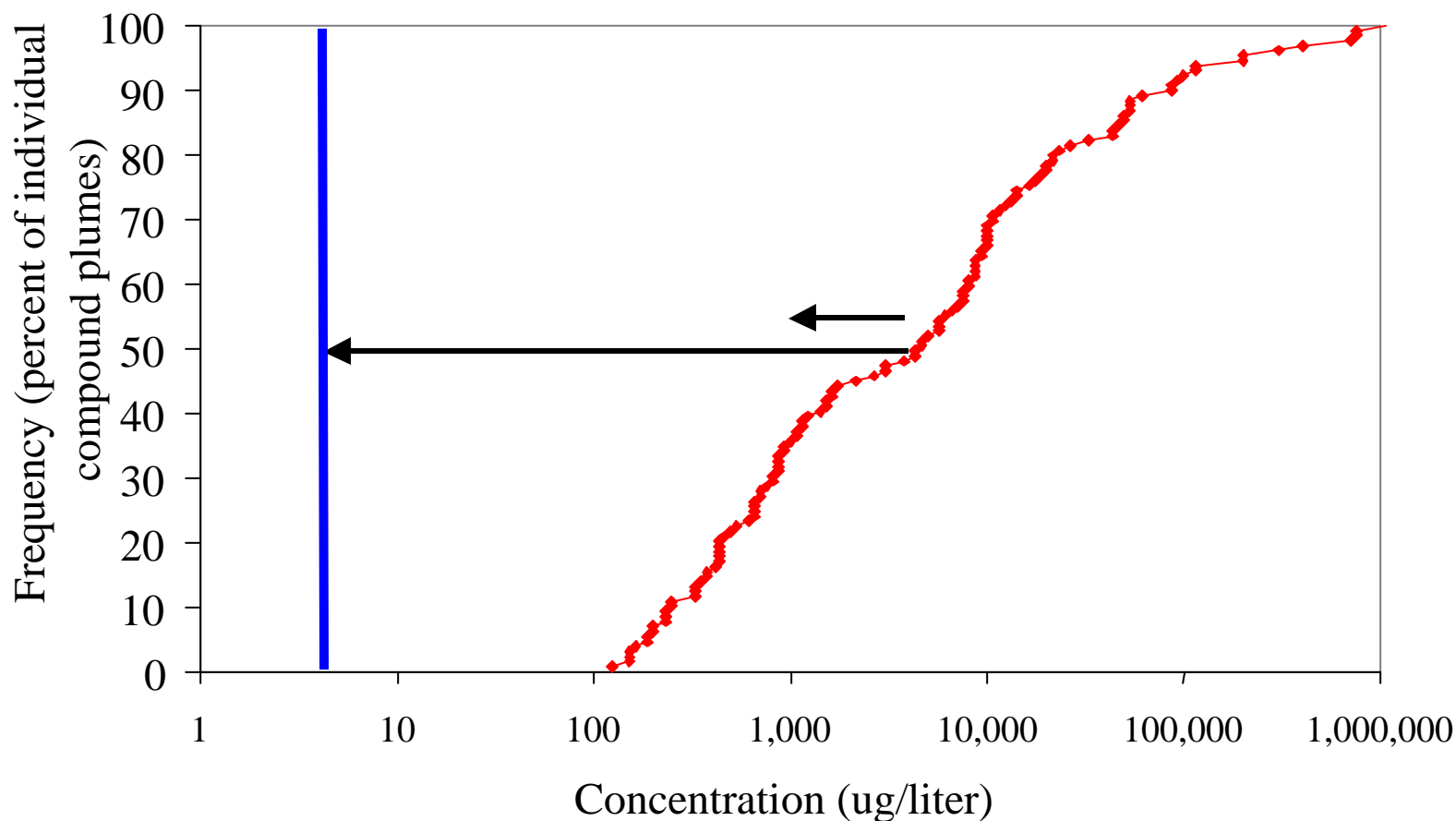
Or Like This





Benefit of 70% Removal

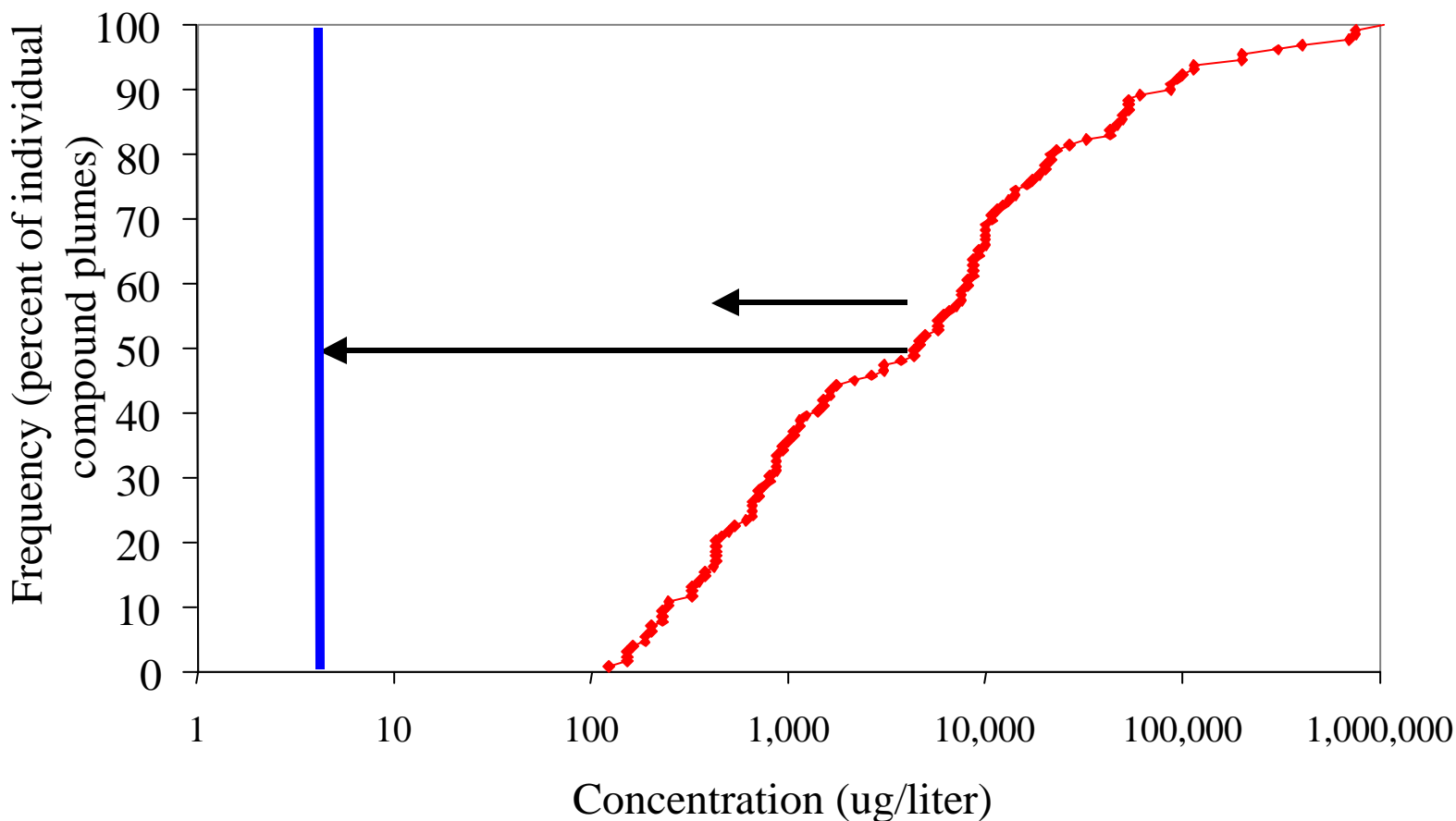
Maximum Concentrations of Chlorinated Organics





Benefit of 90% Removal

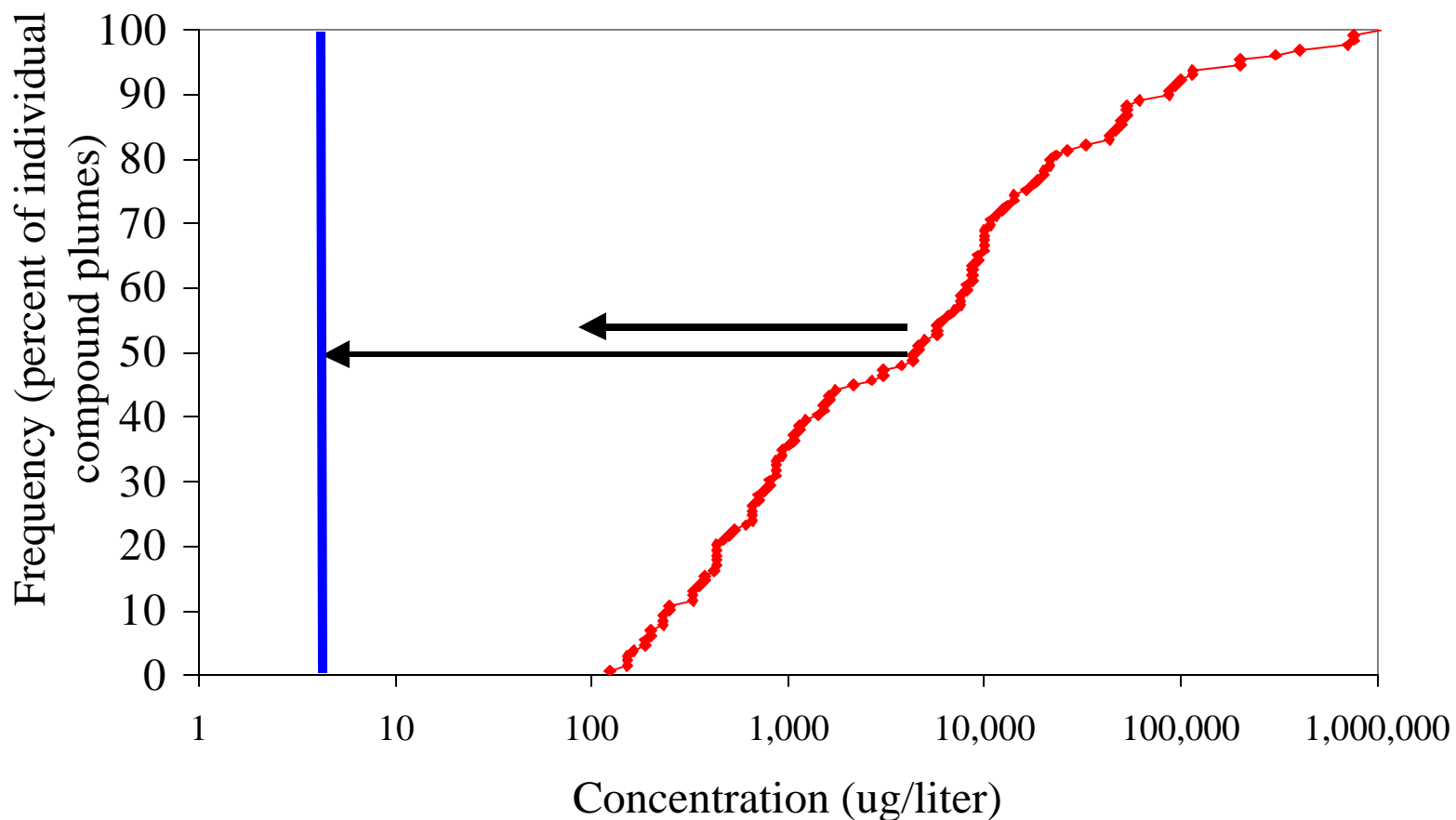
Maximum Concentrations of Chlorinated Organics





Benefit of 99% Removal

Maximum Concentrations of Chlorinated Organics



Promoting Readiness through Environmental Stewardship



Performance of Remediation

Many innovative, cutting-edge, state-of-the-art approaches to site remediation can produce disappointing results.

The site is cleaner after remediation, but not clean, and the immediate product of remedial activity is a need for more remediation.



Pragmatic Definition of Success

The definition of success for a remedial technology should be driven by the need to achieve closure at a site.



An Unworkable Definition

After remediation, ground water in entire plume treated to MCLs

- From the point of Stewardship, most workable.
- Technically, has proven impossible to attain at many sites.



A Workable Definition

After remediation, hotspot actively contained, and plume outside containment treated to MCLs

- Acceptable from point of view of Stewardship
- An approach that has achieved closure in Superfund
- O&M costs associated with maintaining containment



A Workable Definition

After remediation, plume confined to NAPL source area by natural processes

- May be acceptable from point of view of Stewardship
- There are no additional O&M costs associated with maintaining containment
- A common end-point in the UST program.



Generally Unworkable Definitions

Plume receding when it was expanding before remediation.

Plume stabilized when it was expanding before remediation.

- Depends on a statistical evaluation of plume behavior. Hard to make the case.
- The job is not done. Often unacceptable from point of view of stewardship



Workable Definition of Success

A workable definition of success usually invokes a combination of:

active source control or source remediation,

with plume remediation or monitored natural attenuation.